BARBER COLMAN

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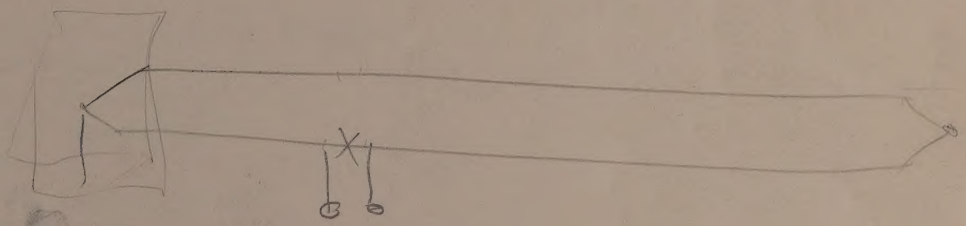
MODEL 272P
CAPACITROL

INSTRUCTION MANUAL



MP MASTER
MA32106

BARBER-COLMAN COMPANY
Industrial Instruments Div. • Rockford, Ill., U.S.A.

INTRODUCTION

This instruction manual is designed to help you secure maximum benefits from your new Model 272P Capacitrol. It should be given to persons responsible for installation, operation and maintenance of this instrument.

Your Barber-Colman factory trained field engineer is always available for further help in the solution of your control problems. Offices are located in all principal cities.

Barber-Colman Company
Industrial Instruments Division

Litho in U.S.A.

JANUARY 1970

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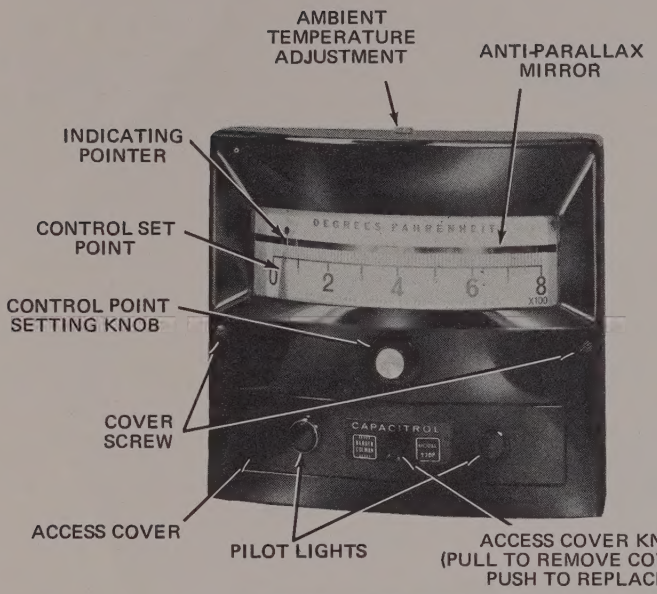
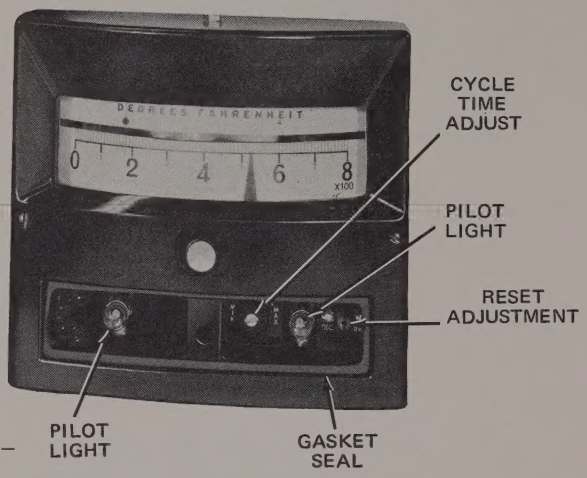
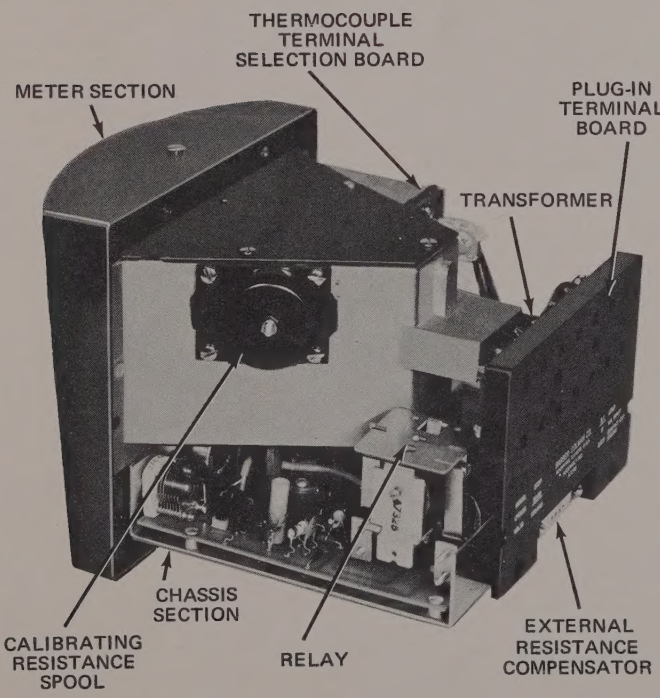


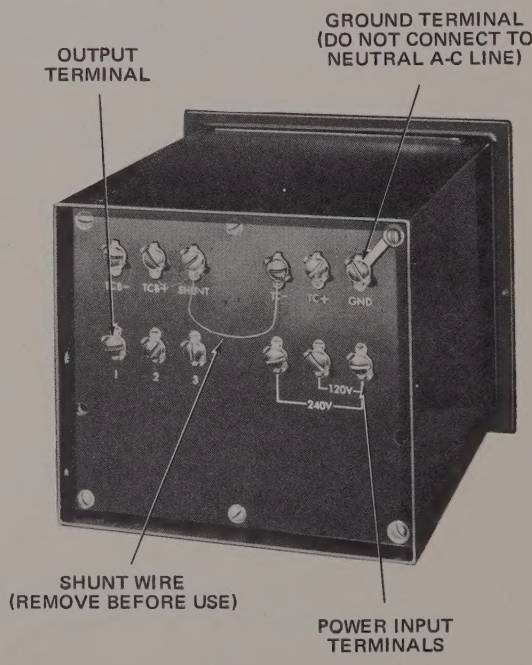
MODEL 272P CAPACITROL



FRONT VIEW – ACCESS COVER REMOVED



METER-CHASSIS UNIT



REAR VIEW OF HOUSING

SPECIFICATIONS

Scale Length
5 inches

Minimum Span
9 mv or 0-300° F - Type J

Calibrated Accuracy
± 1% of full scale

Sensitivity
90 microamps for full scale deflection (nominal)

Internal Resistance
11 ohms per millivolt (nominal)

External Resistance
Calibrated for 15 ohms and supplied with replaceable compensator to make up difference between calibrated resistance and actual value of external resistance

Compensation
a) Automatic cold junction temperature compensation Range 40 to 130° F

b) Copper coefficient compensation. Range 40 to 130° F

Thermocouple Break Protection
TCB furnished

Control Sensitivity
0.1 of 1% of full scale

Control Contacts
One set of SPDT contacts

Contact Ratings	120 v	240 v
Resistance loads	5 amps	2.5 amps
Inductive loads	2.5 amps	1.25 amps

Proportioning Band
2 1/2% of full scale

Cycle Time
Adjustable from approximately 3 to over 30 seconds

Control Adjustment
External control set point knob adjustable over 100% of scale. Reset control internally adjustable

Power Requirements
9 volt amperes

Power Supply
Interchangeable: 120 and 240 volts a-c, 50-60 cycles

Dimensions and Weights

Overall Dimensions
6 7/8" wide x 6 1/4" high x 9 5/8" deep

Cutout for Flush Mounting
6 1/8" wide x 5 9/16" high
NOTE: Meter housing will extend approximately 8" from back of panel when flush mounted

Net Weight
9 pounds

Shipping Weight
12 pounds

MATERIAL WARRANTY

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid, to the factory at Rockford, Illinois.

DESCRIPTION

General Description

The Model 272P Capacitrol is a millivoltmeter-type indicating two position on-off controller utilizing a time proportioning "Truline" feature to minimize load temperature variations. The unit employs a solid state trigger-type circuit to operate a relay having single pole double throw action.

The instrument is suitable for any application compatible with this relay action including the operation of external relays, contactors, solenoid valves, valve control motors or any electrical load which does not exceed the instrument relay ratings.

Control Action

The 272P output utilizes a SPDT relay with a contact rating of 5 amperes at 120 volts, or 2.5 amperes at 240 volts for non-inductive loads such as small electric heating elements. For inductive loads such as solenoid valves or contactors, these ratings are decreased 50%. The proportioning band is fixed at approximately 2% of full scale. Two adjustments, "reset" and "cycle time," are adjustable from the front of the instrument as described under Control Adjustments. The instrument's cycle time is adjustable from 3 to over 30 seconds. Control action occurs when the meter indicator is within the proportioning band range of the instrument, located in the area of the control set pointer. After the controlled load has become thermally stable, any offset between the meter indicator and the control set point can be corrected with the reset adjustments as described under Control Adjustments.

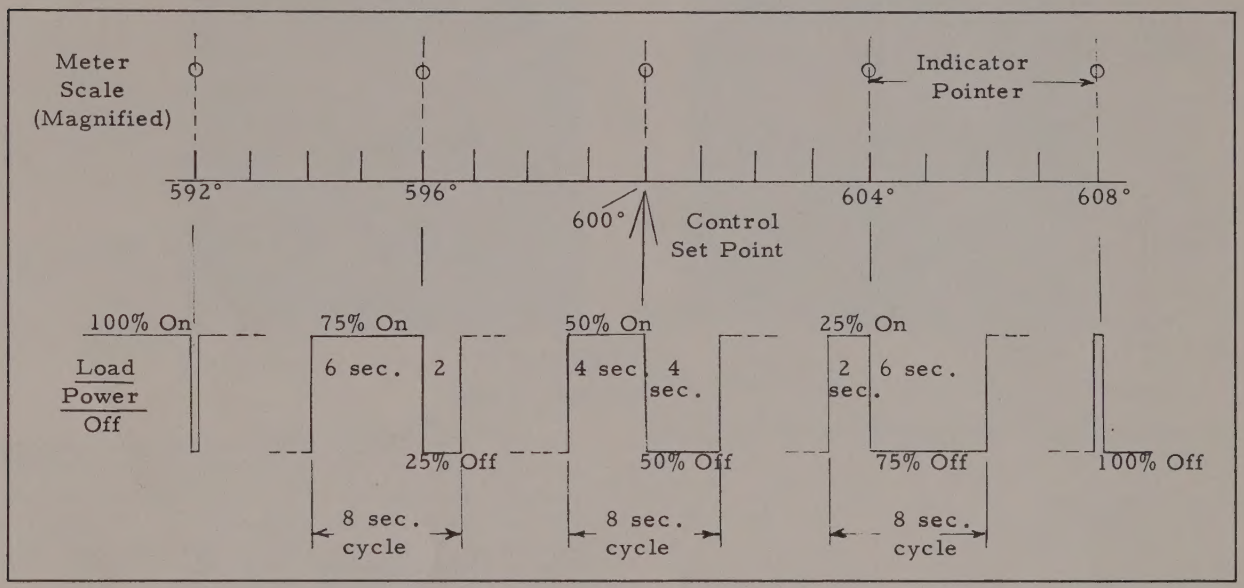
Description of Electronic Circuit

The Model 272P uses a transistorized oscillator and a silicon controlled rectifier (SCR) for control of the load temperature. At a position on scale below control point, the transistor collector current is great enough to trigger the silicon controlled rectifier, energizing a relay so that power is applied to the load or process. As the indicator approaches control set point, a small vane or flag, suspended from the indicating pointer, passes between two flat coils mounted on the control set arm. The presence of the flag between the coils changes the tuning of the transistor base circuit. With the flag fully between the coils, the collector current decreases to a point where the SCR ceases to conduct, de-energizing the relay and the power to the controlled load. Time proportioning occurs when the flag traverses a fixed distance between the coils as discussed under the next section. Proportioning action is accomplished by changing the tuning of the transistor's emitter circuit, using a voltage variable capacitor. Varying the d-c voltage applied to the capacitor changes its capacitance and thereby the tuning of the emitter circuit. The "cycle time" adjustment regulates the d-c voltage applied over a certain time period and hence determines the cycling rate.

"Truline" Time Proportioning Control

Truline Proportioning action occurs when the flag is fully between the coils, and its position in the coils automatically determines the percent on time versus off time during one cycle, or the period of time power is applied to the controlled load. After the indicator has reached the proportioning band (with the flag between the coils) and moves upscale toward the control set point, the percent on time decreases and the percent off time increases. At control point, it is approximately 50% on and 50% off. This action, called "time proportioning" results in a modulation of power to the controlled load, minimizing overshoot and undershoot for close tolerance control.

An illustration of time proportioning action is shown below. In this example, the time of one complete cycle could be adjusted from 8 seconds to over 30 seconds, or decreased to 3 seconds. Adjustment is described in the section on Control Adjustments.



Example of Time Proportioning Action as the Meter Indicator Moves Upscale Through the Proportioning Band of a 0-800° F Meter

INSTALLATION AND START-UP

Unpacking the Instrument

This precision instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report damages to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION: Handle with care.
Safeguard instrument from shock before and after installation.
Avoid oil accumulation and exposure to moisture.
Keep instrument temperature under 130°F and over 40° F.

Mounting Instructions

Locate instrument to avoid excessive vibration, shock, and temperatures outside the range of 40°F to 130°F. Avoid furnace walls, radiation of heat, machine frames, and outside walls. Provide suitable shelter against moisture and temperature extremes if installed outdoors. Refer to appropriate drawing for mounting details.

Power Wiring

The unit is suitable for 120 v or 240 v, 50/60 cycles a-c, by choice of proper terminals on the back of the instrument housing. Solid wire (14 gauge) is suggested for power wiring. If stranded wire is used, tin the ends to provide secure connections.

Wiring should be in accordance with applicable electrical codes. It is recommended that a fused switch be inserted in the power line to the load. The fuse size should never exceed 5 amperes at 120 volts or 2.5 amperes at 240 volts. If load requirements are less than these amounts, the ampere rating can be less. Where maximum protection of the instrument is desired, a 1/8 ampere slow blow fuse may also be added in the power line to the instrument.

The instrument case should be grounded. This is accomplished by attaching the GRD terminal directly to a good ground, such as a cold water pipe.

CAUTION: Do not connect the GRD terminal to the neutral a-c line.

Terminals 1, 2 and 3 are wired internally to the relay contacts with terminal 2 as the common point of the SPDT contact. Terminal 1 is the normally closed contact and terminal 3- the normally open contact as shown in Figure 3. The external wiring diagrams (Figures 4 and 5) show some typical wiring diagrams.

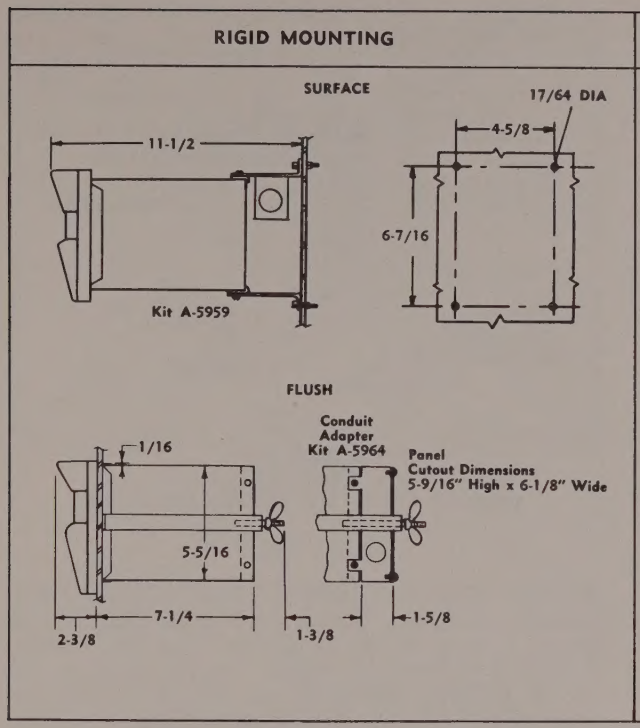


FIGURE 1

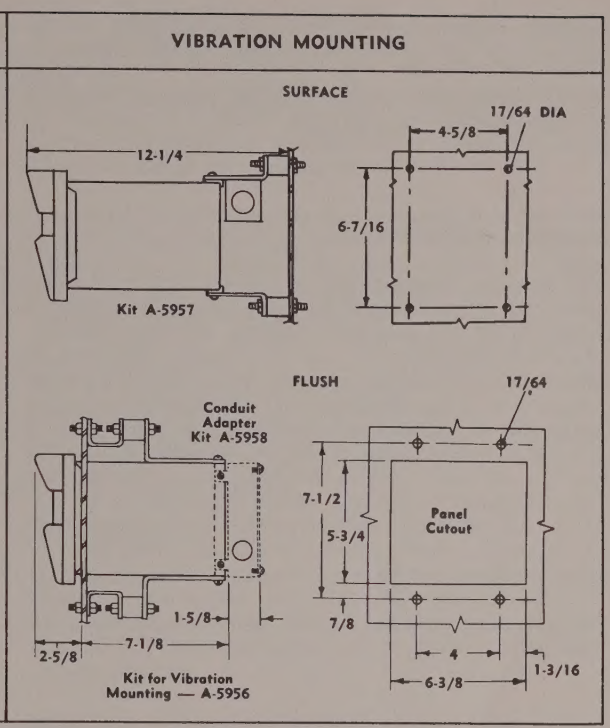


FIGURE 2

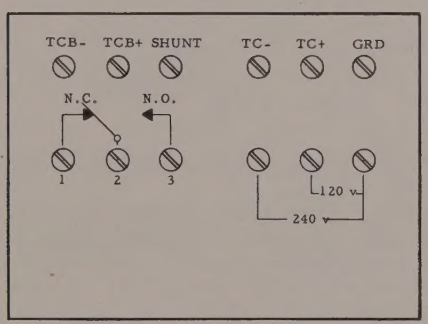


FIGURE 3
TERMINAL LAYOUT

Meter Shunt Wire

After the instrument is installed, disconnect the jumper wire across terminals marked "Shunt" and "TC-". This wire is used to shunt or dampen the meter movement for protection during shipping, handling and installing the instrument, but should be removed for normal operation. Replace the shunt wire when handling or shipping the instrument and position the red control set pointer fully upscale.

Thermocouple Wiring

The single unit meter and chassis plug-in assembly has a thermocouple selection feature which should be checked to see that the thermocouple connections are properly made. This is done by removing the instrument from its case and noting the pin connections on the small terminal board at the rear of the meter enclosure. The leadwire marked "A" should always be connected to pin "A" and the leadwire marked "B" should always be connected to pin "B". If a base metal thermocouple is used (Type J, T or K) the wire labeled "C" should be connected to the third pin, marked "C or D". If a noble metal thermocouple is used (Type R or S) the wire labeled "D" should be connected to this pin.

Do not run thermocouple leadwire with other power or control wiring. Leadwire may be run with thermocouple break (TCB) wires, however. Several thermocouple leadwires may be run in the same conduit if desired.

Use only extension leadwire correct for the type of thermocouple (TC) as specified on the scale. The types most commonly specified are: Iron-Constantan (Type J), Chromel-Alumel (Type K), Plantinum-Platinum 10% Rhodium (Type S), Platinum-Platinum 13% Rhodium (Type R), and Heat-Eye. Ordinary copper wire must not be used for these elements, although it can be used with Barber-Colman Land Radiation Pyrometers and certain other radiation detectors. See Barber-Colman Thermocouple Catalog for a full selection of thermocouple assemblies and extension leadwire.

Proper polarity (+) and (-) of the leadwire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the leadwire can be checked by twisting the two wires together at the far end, heating this junction with a match, and noting the deflection of the meter indicator. An upscale deflection is proof of correct polarity of the leadwire.

The leadwire should then be connected to the thermocouple and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the

leadwire connections at the thermocouple since the leadwire has already been correctly connected to the instrument.

Secure the leadwires firmly under the terminal screws. If desired, spade lugs may be used.

Line Compensating Resistor

The external resistance, for which the meter has been calibrated and as marked on the scale, is the combined resistance of the extension leadwire and thermocouple. Meters are normally calibrated for 15 ohms (Ext. Res. 15 ohms), which allows for more resistance than the average length of leadwire. The balance of the resistance, 15 ohms minus the actual external resistance, is supplied as a removable compensating resistance strip located on the back of the meter plug-in terminal board. The resistance value is marked on the strip, which is attached at the time of the original order. Minor changes in the leadwire length can be made without appreciable error in reading because a high resistance movement is used.

Compensating resistors of other values can be obtained at nominal cost.

Thermocouple Break Protection (TCB)

The instrument is equipped with thermocouple break protection (TCB) to be used if desired. This protection is provided by a small d-c voltage super-imposed onto the thermocouple circuit so that, in the event of a break in the thermocouple circuit, the meter indicator will be driven upscale past the control set point and the instrument control will go to the OFF position. The instrument will operate in a normal manner without the TCB connected, but its use may be desired on some applications to guard against overheating in the event of an open thermocouple.

Methods of connecting TCB are shown in Figure 6. Use the required extension leadwire to make the connections between the instrument terminals and the thermocouple head. Copper wire, 16 to 20 gauge, is generally used to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermocouple leadwire. Although not recommended, an optional method of connecting TCB is to use jumpers at the instrument terminals with short leadwire lengths (10 feet or less). When using longer lengths of leadwire, this method may result in a noticeable error in the meter reading. The amount of TCB error must then be determined. (See section on Meter Adjustments).

To check for correct TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected. When the instrument is powered, TCB is functioning properly if the indicator is driven upscale above the red control set pointer to cause the control to go to the OFF position.

TCB is not effective on radiation detectors because of the compensating network in those devices. Do not connect TCB when the instrument is used in conjunction with a Series 350 Reference Voltage Source. See Series 350 Instruction Manual for complete instructions.

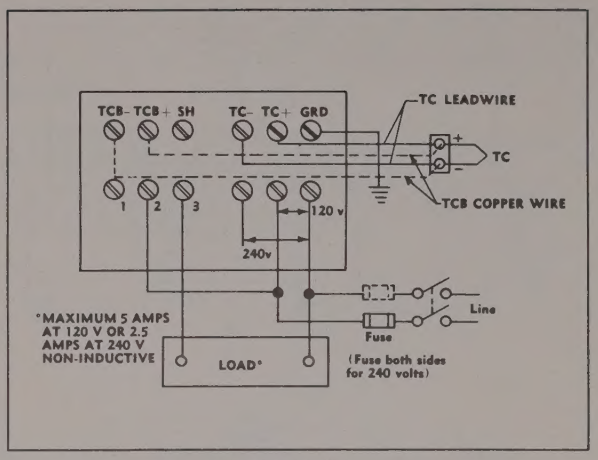


FIGURE 4
TYPICAL EXTERNAL WIRING DIAGRAM

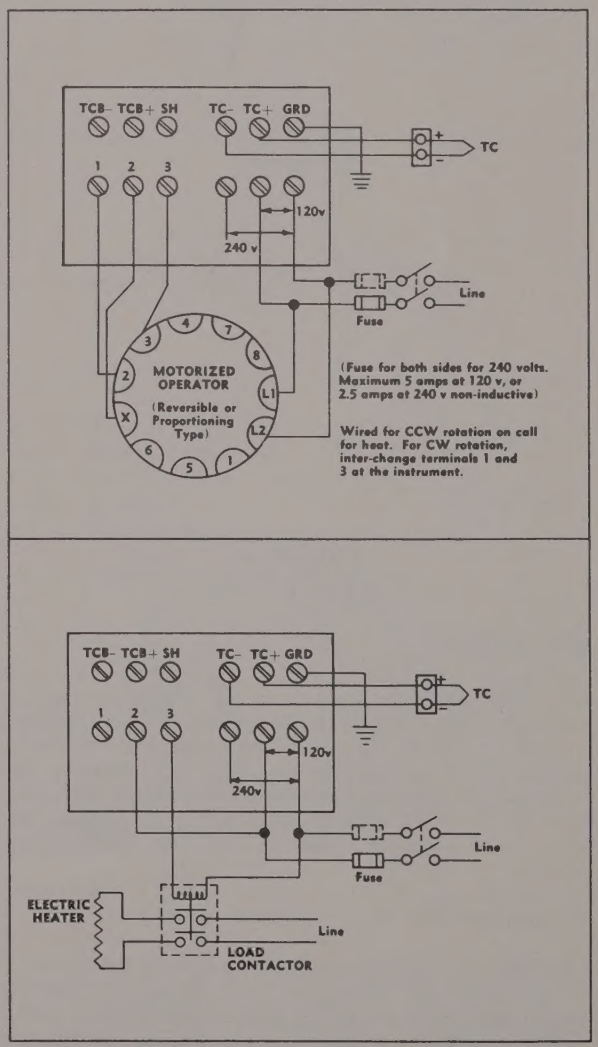


FIGURE 5
MODEL 272P EXTERNAL WIRING DIAGRAMS

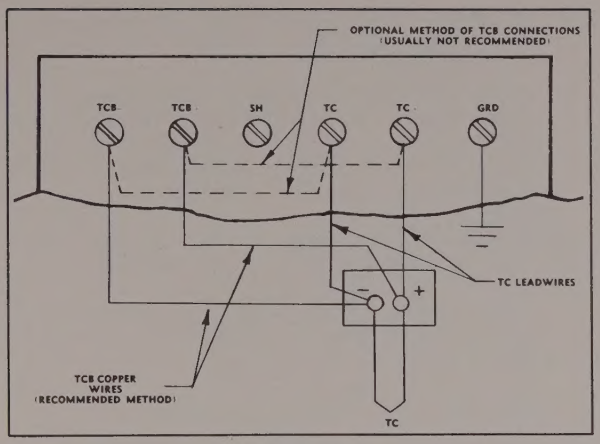


FIGURE 6
TCB WIRING METHODS

OPERATION

The control set pointer is adjusted by use of the knob located just below the indicating scale. The indicating pointer will move to indicate the temperature at the thermocouple. Control action of the Model 272P is instantaneous because solid state devices operate without warm-up time. From start-up, the red light on the front panel will glow until the meter indicator approaches the control set pointer and the region where proportioning action occurs. At this point the red and green lights will cycle on and off until the indicator moves out of this region. When the red light glows, terminals 2 and 3 of the internal relay are closed applying power to the load. When the green light glows, terminals 2 and 1 are closed, removing power from the load.

Removing Instrument from Housing

The meter and chassis comprise a single-unit assembly with connections to plug into the rear terminal board inside the housing. For servicing or interchange of control forms, the complete unit is removed from the housing by completely loosening the two screws on the front face and pulling forward firmly. Do not attempt to pry the unit apart from the housing.

Meter Adjustments

For measuring temperature, thermocouples are the most commonly used sensing devices. They produce a voltage when there is a temperature difference between the "hot" or measuring junction and the "cold" junction located in the meter assembly. Since the difference in temperature between the hot and cold junctions determines the amount of millivoltage produced, it is necessary to keep the cold junction temperature constant, or to compensate for any changes that occur at this point. The Series 270 instruments compensate for temperature changes at the cold junction through the use of a bimetallic strip. After properly adjusting for ambient temperature, further correction for ambient temperature changes need not be made.

After the instrument has been mounted, and before it has been powered, disconnect the thermocouple at one of the terminals and read the temperature indicated on the scale. The indicator should not read zero, but should come to rest at the ambient temperature. Use a reliable mercury thermometer to determine the correct ambient temperature. (If instrument is mounted in a panel, measure the temperature inside the panel and allow enough time for the instrument to reach inside panel temperature.) If the pointer does not read ambient, slowly adjust the screw located on top of the meter cover until it does.

If a check of cold junction compensation is to be made after a period of operation, heat rise within the instrument housing must be allowed for. Because the rate of heat dissipation depends upon the environment, the heat rise will not be a constant, but will usually vary between 5° to 10° above the external temperature. Where close measurement accuracy is desired, a small thermometer should be placed inside the housing on top the chassis with the bulb near the meter thermocouple selection terminals. After allowing time for the inside temperature to stabilize, an adjustment should be made to set the meter indicator to the thermometer reading.

TCB Compensation:

It is necessary to compensate for TCB only if the meter tends to read significantly high when the instrument is powered. Should it be desired to compensate for this upscale deflection, the reading may be shifted downscale as explained below.

When the instrument previously adjusted for correct ambient temperature, the thermocouple should be held at a steady temperature while observing the difference in meter readings with the unit powered and unpowered. If the difference is discernable, compensation may be made with the ambient temperature adjusting screw. With the instrument powered, turn the screw to lower the indicated reading to the same point on the scale as observed when the power was off. The cold junction or ambient adjustment is thereby also changed downscale. An alternate method of making this check is by making and breaking the TCB circuit.

Control Adjustments

Good practice dictates that final control adjustments should be made after the controller has achieved maximum stability. Reset and cycle time controls are accessible by removing the front access cover, which is removed by pulling the small knob located below the control set point knob.

Reset adjustment provides a means of aligning the meter indicator with the control set pointer to correct for offset. If the meter indicator does not coincide with the control set pointer after the controlled load has become thermally stable, an alignment adjustment should be made. Use a small screwdriver to reposition the reset adjustment capacitor. Turning the reset adjustment counterclockwise will decrease the percent of "ON" time, thereby shifting the meter downscale so as to produce a lower temperature. Conversely, turning the reset adjustment clockwise will increase the percent "ON" time and shift the meter upscale, producing a greater temperature. The reset adjustment should be in small increments with sufficient time allowed after each adjustment to permit the controlled load to again become thermally stable. The proper reset adjustment occurs when the meter indicator coincides with the control set pointer when the load is thermally stable.

Cycle Time Adjustment:

The cycle time adjustment is used to adjust the time of one complete cycle from about 3 seconds to over 30 seconds. Turning the cycle time adjustment clockwise will increase the time period of one cycle, and counterclockwise will reduce it. The proper cycle time adjustment is obtained in the following manner:

> When the controlled load temperature or meter indicator has reached set point, turn the cycle time adjust clockwise, increasing the cycle time until the meter indicator makes a noticeable up and downscale movement. Then turn the cycle time adjustment counterclockwise in small increments, being sure to let the controlled load stabilize after each adjustment. The cyclic variations of the meter indicator and load will decrease and the proper cycle time adjustment is obtained when no perceptible indicator movement occurs. With this cycle time setting, temperature variation can be tolerated, the cycle time can be increased to improve relay and contactor life.

Differential:

A potentiometer is factory adjusted to require approximately a .010" motion of the pointer to cause the control action to change from ON to OFF. This setting handles the majority of applications and should not be readjusted except by a qualified instrument repair man. To change the operating differential of the instrument relay, unplug the instrument from the housing to expose the potentiometer (R2) mounted horizontally on the printed circuit board. It is the disc type blue or silver colored pot, located on the right side of the circuit board. After breaking the glyptol seal, it may be turned by a small screwdriver. Turning CW will widen the differential; CCW will reduce it. Too narrow an operating differential may cause a chatter of the instrument relay.

MAINTENANCE

Routine Servicing

The 272P instrument is well designed and manufactured of high grade components and with normal care will give uninterrupted service for a long time. It is good practice, however, to have information as to service and spare parts for emergency servicing. Where a number of instruments of this series are located together, the single unit meter and chassis plug-in assemblies are interchangeable to allow minimum inventory.

When trouble is encountered, the service man should familiarize himself with the process and instrument application to determine the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems: measurement or control.

Measurement and Control Trouble

Measurement trouble can be detected by observing the pointer position. If the measured temperature is known to be in error, check the following:

(1) Open or broken thermocouple, leadwire or connector.

(2) Deteriorated thermocouple. Compare reading with a test thermocouple.

(3) Check to see that the capacitor is properly connected between the thermocouple input terminal and the ground terminal inside the back panel of the meter-chassis unit. Also ascertain that the instrument is properly grounded.

(4) Accidental shorts, grounds or moisture in the leadwire (especially with asbestos type insulation).

(5) High resistance in leads due to loose connectors, poor splicing, dirty switch contacts, and other faulty connectors.

(6) Problems caused by vibration or shock.

(7) Meter accuracy. This can be checked with a Barber-Colman PA Series Portable Potentiometer.

(8) Errors due to oil and grease. Do not oil or grease any part of the instrument.

(9) Incorrect cold junction (ambient) setting. The correctness of this setting should be checked following any other meter servicing. See page 5.

Control trouble may be detected by observing control point and indicator pointer position. If control action does not occur at control point, do the following:

(1) Check electrical connectors and correctness of line voltage. Ascertain as to whether trouble is internal or external to the instrument.

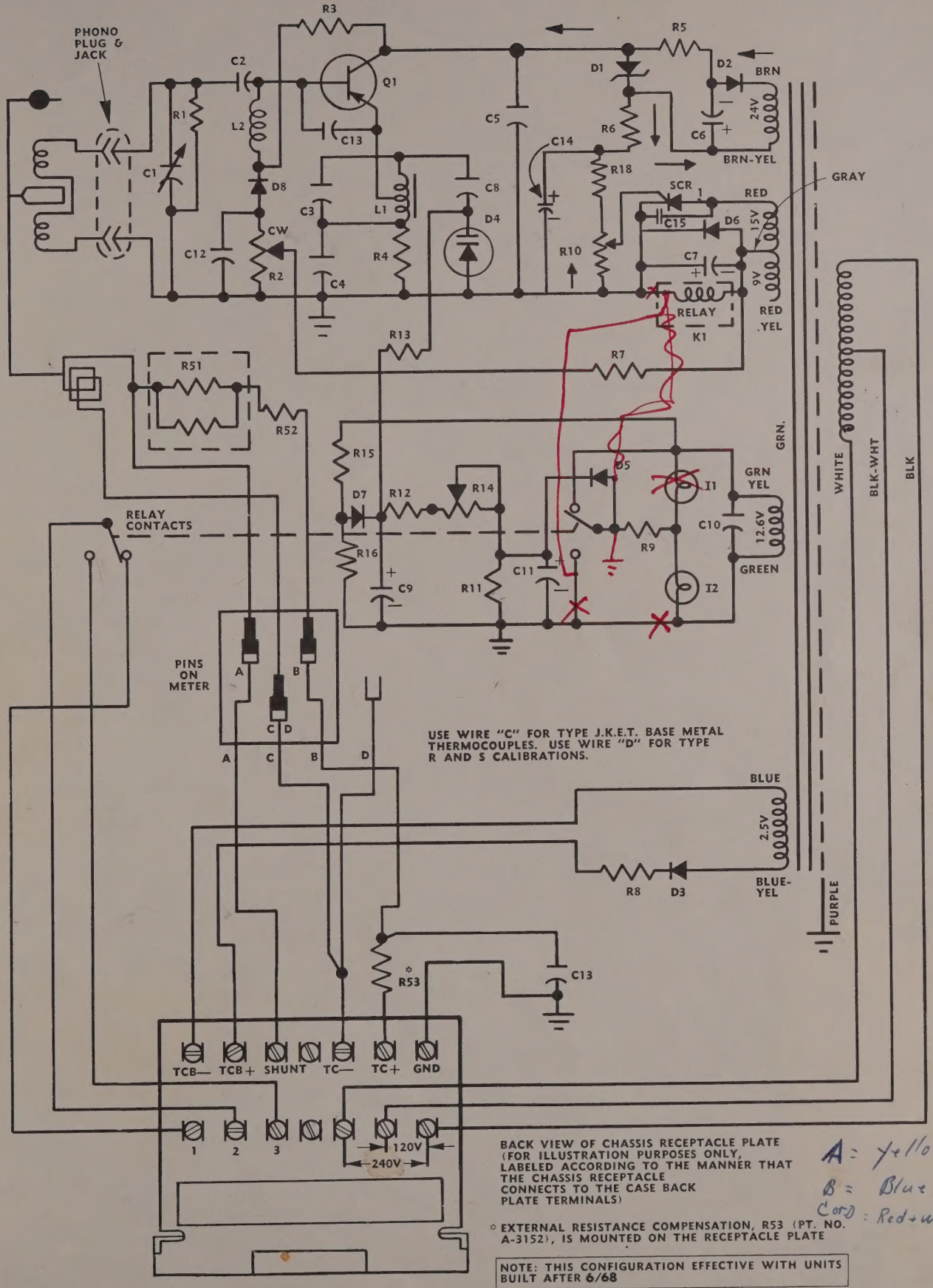
(2) Adjust manual reset as described on page 5.

(3) If the instrument does not operate (i.e., red light does not glow), make sure the indicating pointer is downscale from the control setpoint, then move the setpoint downscale to coincide with the indicating pointer. Turn the reset adjustment clockwise just enough for the instrument to turn on. Return the setpoint to the desired control temperature, allow time for the load to stabilize, and make final reset adjustment as described under Control Adjustment. If instrument does not turn on, or if reset must be adjusted to its nearly maximum position, further servicing is indicated. Contact your local Barber-Colman field office.

Calibration Check

The instrument has been calibrated at the factory to the specified limits of accuracy. Under ordinary circumstances, no further adjustments need be made. If, however, it is later decided to check the calibration, connect a Barber-Colman PA Series Potentiometer (or equivalent) to the thermocouple terminals and follow the steps as outlined in the PA Series Instruction Manual.

An alternative method of making connections to the portable potentiometer is to remove the instrument from its case and place it on a level surface. The leads from the portable potentiometer may then be attached to pins "B" and "C" (pin "B" is positive) on the thermocouple terminal selection board. After setting the external resistance for 15 ohms, the usual calibration procedure is followed.



MODEL 272P – INTERNAL WIRING DIAGRAM

PARTS LIST – ELECTRICAL COMPONENTS

Item	Part Number	Description
C1	39-372-1	Capacitor 2.9-35 pfd, 3.0-2.5 pfd min. 45-35 pfd max.
C2, C4 C12	39-76	Capacitor 250 pfd 500 vdcw ± 20% NPO
C3	39-376	Capacitor 47 pfd 500 vdcw ± 10% NPO
C5, C15	39-103	Capacitor .01 mfd 1000 vdcw GMV
C6, C7 C11	39-153	Capacitor 50 mfd 50 vdcw +150 -10%
C8	39-376	Capacitor 47 pfd 500 vdcw ± 5% NPO
C9	39-260	Capacitor 56 mfd 15 vdcw ± 20%
C10	39-196	Capacitor .22 mfd 100 vdcw ± 20%
C13	39-98	Capacitor 1 mfd 200 vdcw +40 - 20%
C14	CYZR-770	Capacitor 2 mfd 100 vdcw +50 - 20%
D1	37-93	Zener Diode 12 volt 400 mw ± 5%
D2, D3 D5, D6, D7	EYZP-384	Silicon Diode 60 piv at 100 ma
D4	37-60	Voltage Variable Capacitor dc Diode 33 pfd at 4 volts
D8	37-148	Silicon Diode 60 piv at 100 ma (selected for voltage drop of .5v
I1, I2	36-34	Bulb 12.6 volt (Type 53)
K1	A-7325	Relay 325Ω pull-in 10 volt max.
L1	41-130	Coil 2.7 uH max. 1.2 uH min.
L2	41-136	Choke 43 uH ± 10%
Q1	EYZP-623	Transistor (2N4126) PNP Silicon
R1	CYZR-170-4	Resistor 6.8 k ± 10% 1/2 w
R2	29-270	Potentiometer 400Ω± 30% 1/4 w
R3	CYZR-170-1	Resistor 22 k ± 10% 1/2 w
R4	40-77	Resistor 270Ω± 10% 1/2 w
R5	CYZR-133-2	Resistor 1.5 k ± 10% 1/2 w
R6	CYZR-170-47	Resistor 330Ω± 10% 1/2 w
R7	CYZR-170-10	Resistor 120 k ± 10% 1/2 w
R8	CYZR-170-38	Resistor 5.6 k ± 10% 1/2 w
R9	40-94	Resistor 22Ω± 10% 1/2 w
R10	29-256	Potentiometer 250Ω± 10% 1/2 w
R11	40-267	Resistor 220Ω ± 10% 1 w
R12	CYZR-170-43	Resistor 220 k ± 10% 1/2 w
R13	CYZR-170-41	Resistor 1 meg ± 10% 1/2 w
R14	29-59-1	Potentiometer 5 meg ± 20% 1/2 w
R15	40-1693	Resistor 33 k ± 5% 1/2 w
R16	40-9-1	Resistor 10 k ± 5% 1/2 w
R17	A-3152	Line Compensating Resistor Assembly
R18	CYZR-170-32	Resistor 470Ω± 10% 1/2 w
R51	A-3049-1	Temperature Compensation Assembly
R52	A-1847	Calibration Resistor
R53	A-3152	External Resistance Compensation
SCR1	37-94	Silicon Controlled Rectifier
T1	30-317	Power Transformer

SUGGESTED REPLACEMENT PARTS TO KEEP ON HAND

Quantity	Part Description	Part Number
2	Type 53 Pilot Lamps	36-34
1	Replacement Thermocouple (Refer to Thermocouple Catalogs)	
1	Control Chassis	A-7296
	or	
	Single Unit Meter-Chassis Assembly	A-7324

We do not recommend electronic component replacement except by well equipped instrument repair shops.

Barber-Colman, Industrial Instruments Division, maintains service and repair facilities in many major cities in the United States and Canada. Consult your yellow page directory.

MP MASTER MA32106